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AFIT/GLM/LSM/90S-52

APPLYING DYNA-METRIC TO ANALYZE
PAKISTAN AIR FORCE F-16 AIRCRAFT
DEPLOYMENT KIT EFFECTIVENESS

THESIS

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AFIT/GLM/LSM/90S-52

The opinions and conclusions in this paper are those of the author and are not intended to represent the official position of the DOD, USAF, or any other government agency.

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THESIS

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-- I U SHAD

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Abstract

The Pakistan Air Force (PAF) uses Forward Operational Bases (FOB) Deployment Kits, a version of the War Readiness Spares Kit (WRSK) used in the United States Air Force (USAF). The purpose of this kit is to stock repair components required to ensure uninterrupted supply support during operational exercises and war deployments.

This study was designed to evaluate the existing PAF Deployment Kit by applying the Dyna-METRIC inventory model. A literature search revealed that the Dyna-METRIC Microcomputer Analysis System (DMAS), developed by the Dynamic Research Corporation (DRC) for use on personal computers, was a suitable tool by reason of its usefulness, economy, and greater chance of application in the PAF. DMAS was used to analyze a representative kit of 75 items to study effectiveness of stock levels required to generate an optimum number of sorties and to ensure the availability of a greater number of Fully Mission Capable (FMC) aircraft throughout the period of deployment. The study successfully identified required stock levels, recommended deletion of excessive inventory, and also proposed additional levels in the kit of Problem Parts, the parts most often required to prevent the grounding of aircraft. For the purposes of this study the terms "part " and "item" would mean a line item. Both the terms will be interchangeably used throughout this text.

APPLYING DYNA-METRIC TO ANALYZE PAKISTAN AIR FORCE F-16 AIRCRAFT DEPLOYMENT KIT EFFECTIVENESS

I. Introduction

General Issue

The requirements are unlimited and the resources limited. This homily used in the business world holds true for the Pakistan Air Force (PAF), too. Faced with real or perceived threats, the PAF needs to be prepared to be able to meet the challenge. In order to make the PAF an effective and balanced component of the overall defence apparatus, it must be ensured that a maximum return, in terms of operational output, is generated at the least possible cost. With this objective in mind, research is continuously done in various logistics and engineering fields. Due to increasingly scarce resources, the United States Air Force also feels the need to develop more efficient methods of enhancing operational capabilities. "One of the most notable efforts in this area is the RAND-developed Dyna-METRIC model which translates logistics spares information into capability assessment output" (4:22). This study will consider the use of Dyna-METRIC to examine the effectiveness of spares levels in the PAF F-16 Forward Operating Bases (FOB) Deployment Kits.

Background

Pakistan is located in a region of vital strategic importance to the superpowers. The disruption of diplomatic relations between the USA and Iran broke a vital geopolitical linkage that was once considered to be a political pressure on the Soviet Union to block her expansion in that region. This significant event changed the whole strategic scenario rendering Pakistan a key player in the region (2:12). Moreover, the invasion of Afghanistan by the USSR in 1979 also drastically changed the strategic environment and enhanced the defense needs of Pakistan. "A southward thrust by the USSR remains its most critical geopolitical strategy . . . " (2:16). In order to elevate this issue to the international level, the February 1985 issue of the Defence and Foreign Affairs Journal was totally dedicated to explaining Pakistan's critical defense needs due to continued threat from the Soviet Union, Afghanistan and India. In view of her important strategic role and peculiar environment, F-16 aircraft were supplied in order to enable Pakistan to raise the cost and uncertainty of Soviet/Afghan, and Indian military action (12:128-129).

Problem Statement

In the absence of a reliable measurement tool, the effectiveness of the F-16 aircraft Forward Operational Bases (FOB) Deployment Kit to support sortie generation and availability of Fully Mission Capable (FMC) aircraft during exercises and war deployments cannot be predicted. There also is no way to study the relationship between an increase in the kit stock levels and changes in the output, measured in terms of

operational capability, a measure extremely useful in the area of decision making.

Purpose

The purpose of this research was to demonstrate the appropriateness of using the Dyna-METRIC inventory model to examine effectiveness of the Pakistan Air Force F-16 FOB deployment kit, a version of the War Readiness Spares Kit (WRSK) used in the USAF.

Various techniques are employed to determine spares levels for the FOB Deployment Kit; nevertheless, PAF does not use computer simulation techniques which could directly relate mission effectiveness to the spares level. Therefore, the existing calculations, manual or computer aided, are unable to ensure the degree of efficiency and confidence that could be obtained with the help of a Dyna-METRIC model.

Dyna-METRIC has been proved to be an effective and valuable management tool for assessing operational capabilities of a unit or a group of such units involved in a joint operation on a particular front. "The model depicts the impact of logistics resources on operational scenarios and then describes those impacts in terms that the Air Force manager can use to resolve potential support shortfalls." (4:28) In this research, the model was used to predict optimum reparable spares levels required in the FOB Deployment Kit to support planned operations in terms of sorties generated based on FMC aircraft availability. For the purposes of this study the terms "part " and "item" would mean a line item. Both the terms will be interchangeably used throughout this text.

II. Literature Review

The Model Background

Feeny and Sherbrooke initiated work on METRIC in 1966. Extensive research was conducted to develop this stationary, multi-echelon, multi-indenture inventory/repair system. The initial model utilized s-1 and s-2 inventory policies. The multi-echelon technique (METRIC) was developed in 1968 by Sherbrooke. Later, in 1973, the MOD-METRIC model was developed by Muckstadt and enhanced the capability of the METRIC technique to allow consideration of multi-indentured systems. Muckstadt also developed the Consolidated Support Model (CSM) in 1976. "CSM extends the METRIC type analysis to consideration of a three echelon supply system consisting of a depot as well as intermediate and base repair facilities" (4:14).

The Model Parameters

Sortie rates, mission changes, phased arrival of components, repair sources, and interruption of transportation are dynamic parameters usually involved in using a Dyna-METRIC model. The model is capable of handling transient demands placed on component repair and inventory support that results from the dynamic characteristics of the situation at hand. The model does this "by implanting a set of analytical mathematical equations describing the dynamic behavior of component repair queuing system, hence, the term 'Dyna' in the title of the model" (5:5). The name METRIC was borrowed from Sherbrooke and stands for Multi-Echelon Technique for Recoverable Item Control. "It is a

mathematical model used to compute optimal inventory requirements for steady-state activity level" (5:5).

Internal Functions. Dyna-METRIC determines the expected sortie rate that can be achieved with a given stock level or the optimal stock level required to generate a fixed sortie rate. Dyna-METRIC is 15,000 lines of FORTRAN code designed to produce various useful outputs in the form of performance, Problem Parts, and pipeline levels. The model looks at an aircraft as an entity which would function only if all of its parts work. If a reparable part breaks down and its replacement is not available, the aircraft is declared NMCS (Not Mission Capable Supply) and remains in this status until the required component is made available. The components are considered either LRUs (Line Replaceable Units) or SRUs (Shop Replaceable Units). Depending on the maintenance policy, the Dyna-METRIC model considers two possible cannibalization options: either prohibited or full cannibalization mode. Dyna-METRIC can be used for one or more bases at a time. The model looks at the base repair facilities or a centralized repair facility of two bases known as Central Intermediate Repair Facility (CIRF). However, a base may or may not be associated with a CIRF. The model may or may not be run in this way. This is shown in Figure 1. All reparable generations are shown to have gone through the on-base repair facility before moving on to the repair depots which are considered outside the repair model. The direction of the arrows indicate movement of the reparable generations from a base to the repair facilities and back. A deep look at the model indicates the existence of an unlimited source of supply capable of replacing the existing aircraft components within a specific

lead time (total time between a part's being ordered and being received). The lead time, therefore, bears a specific significance (4:22).

> The actual focus of the model is on the set of repair facilities and arrows in the diagram (in other words, the pipeline). The level of each part in every pipeline is calculated for a given day. These parts are then considered to be not available for use on an aircraft. These aggregate numbers are then subtracted from the total number of parts of each type which are to determine the number of mission capable aircraft for that day. Those aircraft that do not have any holes are then used to 'fly' the required number of sorties as defined by the user. (4:22)

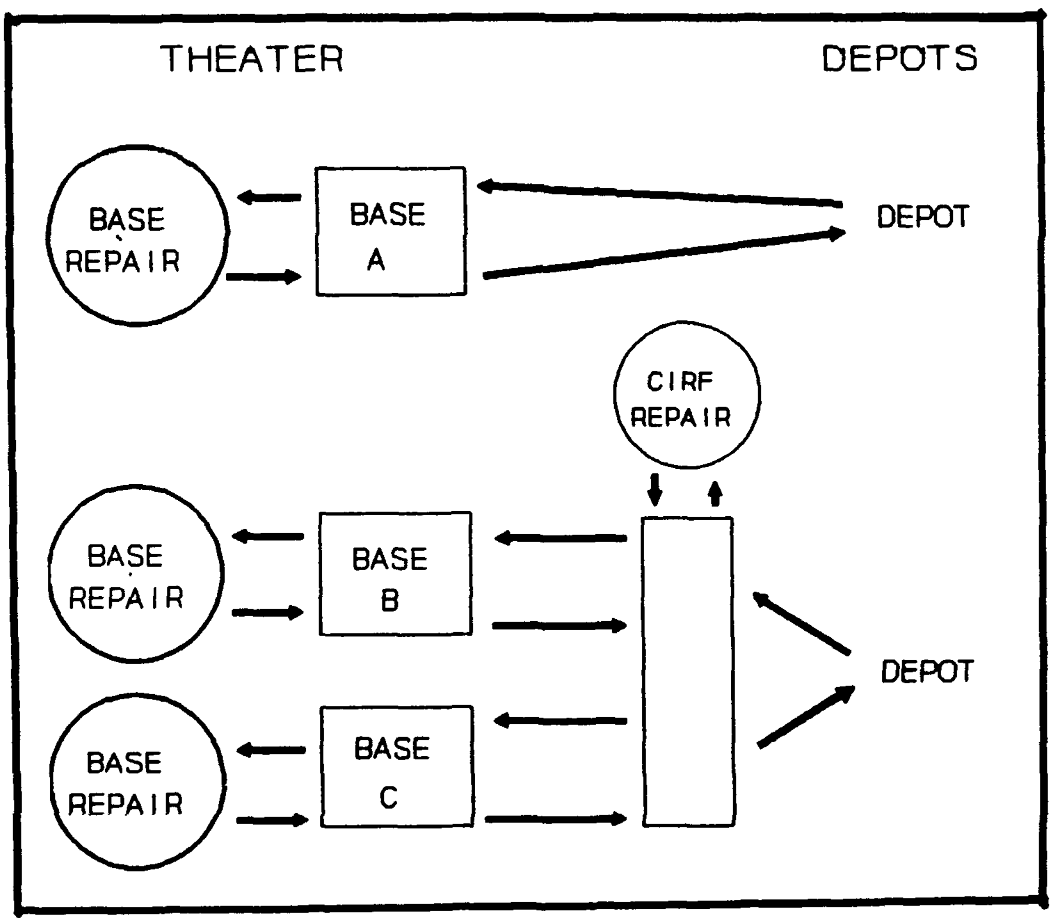


Figure 1. Dyna-METRIC View of the World

The Dyna-METRIC model is not designed to consider certain other factors and environments such as crew availability and the requirement for consumable items necessary for mission capability. Moreover, the model measures performance of the whole weapon system instead of individual aircraft.

> Although we talk of individual aircraft, the Dyna-METRIC model actually never looks at individual aircraft. The number of grounded aircraft is determined by probable distributions of holes across all weapon systems at individual bases. (8:23)

A homogenous Poisson process is the basis of the mathematical theory used in the Dyna-METRIC model. The following definitions will be used:

$X(t)=$ number of items in the resupply system at time t

$F(s,t)=$ probability that a service started at time s is completed by time t.

$M(s)=$ item repair demand rate at time s. (4:15)

The repair capacity will always be assumed as excess, repair and demand processes are independent, and $X(t)$ will have a Poisson distribution with mean $\lambda(t)$ where

$$\lambda(t) = \int_{t=0}^{t} [1 - F(s,t)]\, M(s)\, ds$$

> This is the basic equation used in Dyna-METRIC. It states that the mean number of items of any one type in the supply at time t is a function of all demands for that item and the capability to repair the items over the elapsed time period. It allows for modelling the intensity of demands as well as the repair capability over time. (4:15)

Basic Calculation Steps in Dyna-METRIC. First of all, basic item data that describe the time dependent demand distribution M(s) and

repair time distribution F(s,t) are read. The model starts computing three average time delay values. We shall indicate these delay values by T_A, T_B, and T_C. The average delays T_A, the first in the series, may be caused by nonavailability of test equipment or its spare parts. T_A is calculated by a mean value simulation scheme. T_B will denote the LRU delays which may occur because of nonavailability of LRU spares. T_C, the third delay, is calculated on the basis of the proposed base repair re-supply pipeline and is combined with the data and considered in the loop by the help of calculations. Finally, the fill rates and the other stockage measures are computed by the model, enabling the output to be printed. The time delay measures are used to compute NMC rates, sortie rates, and many other aircraft readiness measures (4:16).

Dyna-METRIC Outputs

A great deal of information is created as a result of each run of the Dyna-METRIC model. The data thus generated consist of information on performance, stockage, Problem Parts and pipeline. The available options may be utilized to obtain the desired output of each day of the operations. Performance information and problem parts, however, are the two important fields often utilized in analysis. The model provides performance information in terms of NMCS aircraft, sorties flown and back orders for the day specified by the user. The expected number of NMCS aircraft on a specified date (full or no cannibalization mode) are based on a distribution and doesn't represent an absolute value.

The same logic is applied to calculate the sortie rate for a particular day. The total back orders figure is worked out by the model by accumulating the number of expected holes in the aircraft. The

preceding three functions will provide important information on the state of the logistics support for the system. Nevertheless, the values are not as absolute as they appear on the outputs because they represent ranges of values based on a distribution (4:23).

The Model Limitations

No model can completely replace real-world conditions. Hence, application of a model may not be expected to meet all situations alike. The user must know its limitations before applying a model to solve a particular problem. In certain conditions, model limitations will suggest checking the results against other authenticated sources (9:viii).

The Dyna-METRIC's known limitations are listed below:

1. Repair procedures and productivity are unconstrained and stationary except when repair capacities are explicitly stated.
2. Forecast sortie rates do not directly reflect flight-line resources and the daily employment plan.
3. Component failure rates vary only with flying intensity.
4. Aircraft at each base are assumed to be nearly interchangeable.
5. Repair decisions and actions occur only when testing is complete.
6. Component failure rates are not adjusted to reflect previous FMC (Fully Mission Capable) sorties accomplished.
7. All echelons' component repair processes are identical. (9:viii).

The Model's Assumptions

A model may be appropriately used if its capabilities and limitations are viewed simultaneously and assumptions developed. The underlying mathematical concepts of the model are dealt with in

greaterdetail in RAND Corporation's publication No. R-2785-AF, dated July 1982 (8). In addition to the above limitations, the user must consider the following assumptions before making a decision to use this model:

1. Average repair times are stationary about their mean.

2. Given the necessary parts and equipment are available to repair a component, repair of the component will never be delayed due to lack of service capability (i.e., there is infinite service capacity).

3. All echelons of resupply are assumed to have identical repair processes (i.e., repair times are identical).

4. Components require testing prior to repair. That is, components can queue based on available test equipment.

5. Demand for LRUs is instantaneous, but the demand for SRUs is not discovered until the parent component is received and tested at the repair facility.

6. Aircraft are semi "homogeneous" for any given base. The model assumes that the aircraft components are interchangeable given cannibalization is permitted.

7. Sortie rate is unconstrained by flight line limitations (e.g., personnel, weather).

8. Aircraft components fail at a given rate based on flying hours only.

9. The daily demand rates follow a Poisson probability distribution and are a function of time for each pipeline.

10. The repair probability function is independent of the probability distribution generating the demand rate.

11. Under cannibalization, the model assumes the ability to instantly consolidate shortages onto the smallest number of air frames at no cost (1:34).

Dyna-METRIC Applications

Use on Mainframe Computers. The assessment of F-16 WRSK spares performance with the Dyna-METRIC model was based on the article published in the Spring 1983 issue of the Air Force Journal of Logistics

written by Dr Raymond Pyles of the RAND Corporation, and Lieutenant Colonel Robert S. Tripp, USAF. The phenomenal growth of the F-16 aircraft budget from approximately two billion to three billion dollars and other financial constraints in the period 1980-82 led to the F-16 quarterly spares assessment. The Dyna-METRIC model was used to answer the following questions:

(1) How well did available peacetime operating stock (POS) and war reserve material (WRM) support flying objectives in peacetime and wartime?

(2) What items limited flying objectives?

(3) What could be done to alleviate these limiting factors?

A three year supportability period was designed into the Dyna-METRIC assessment (10:33-34). Ogden Air Logistics Center (ALC) developed a Dyna-METRIC Readiness Capability Assessment Processor (consisting of 18 steps) which developed a matrix output file loaded onto the VAX-11/80 computer and processed by the 4.4 version of the Dyna-METRIC model. The output of the model is then analyzed and formal assessment of the data is performed (10:34).

Coronet Warrior. The Tactical Air Command conducted a 30-consecutive day flying exercise in July-August 1987. The 94th Tactical Fighter Squadron from Langley Air Force Base participated. The primary purpose of exercise "Coronet Warrior" was to test and validate the Dyna-METRIC model and to study if it could effectively be used to assess the potential of the existing WRSK to support wartime requirements. A given number of spares were provided to the participating fighter squadrons to see if the predicted sortie generations based on Dyna-

METRIC computations could be achieved during the 30 consecutive days of operations. The day-by-day flying effort considered by the model was studied based on the following two key assumptions:

1. Dyna-METRIC assumes that repair is unconstrained by equipment and technicians (personnel), and

2. That cannibalizations are 100 percent successful and completed instantaneously.

The results of the exercise turned out to be better than what was predicted. As opposed to the 91 percent rate predicted by Dyna-METRIC, the unit actually accomplished 98 percent of the tasked sorties. The unit had 17 FMC aircraft at the end of the exercise as opposed to the 4 predicted. The analysis also indicated that demands for spare parts were less than expected. The repair time was also less and the technicians performed better than predicted. The ability of the model to predict Problem Parts was considered unique. There was only one part with demand greater than the forecast. However, the WRSK wasn't fully utilized; instead, only 35 percent of the parts were issued. Dyna-METRIC adequately predicted sortie generation and FMC aircraft availability where input data were reliable (8:1).

Dyna-METRIC Vs D029. The idea behind the Dyna-METRIC model is its utility as an efficiency tool specifically directed to affect cost reductions in War Readiness Spares Kits (WRSK). USAF approved Dyna-METRIC to compute their WRSK in January 1988. In March 1988, Air Force Logistics Command (AFLC) implemented Dyna-METRIC in the Weapon System Management Information System Requirement Execution Availability Logistic Module (WISMIS/REALM). An objective analysis by AFLC on F-15,

F-16 and F-111 WRSK indicated reduced spares requirements of more than $200 million. (11: cover sheet).

A comparatively short but impressive report given in the Air Force Logistics Command Material Analysis Technical Report (11:1-7) analyzed the advantages of Dyna-METRIC; implementation results; comparison of WRSK of F-15, F-16 and F-111 aircraft between D029 and Dyna-METRIC computed costs; and comparison of WRSK depth. The report demonstrated significant reductions in quantities and costs of WRSK when compared to the system previously used (D029) to make the computation. Another AFLC report issued earlier in 1987 explained in detail how Dyna-METRIC requirements were leaner and cheaper compared to the previous system's (11:2). The computations of the WRSK requirements by the previously used D029 system and Dyna-METRIC were compared. Table 1 and the graph in Figure 2 show in detail how Dyna-METRIC reduced requirements costs for these weapon systems by $211 million.

TABLE 1

COMPARISON OF WRSK COST

Weapon System	Number of Authorized Buy Kits	D029 Computed Cost	Dyna-METRIC Computed Cost	Reduction In Rqmts Cost
F-15	23	$1,163M	$1,000M	$163M
F-16	32	$1,187M	$1,146M	$ 41M
F-111	6	$ 465M	$ 458M	$ 7M
Total	61	$2,815M	$2,604M	$211M

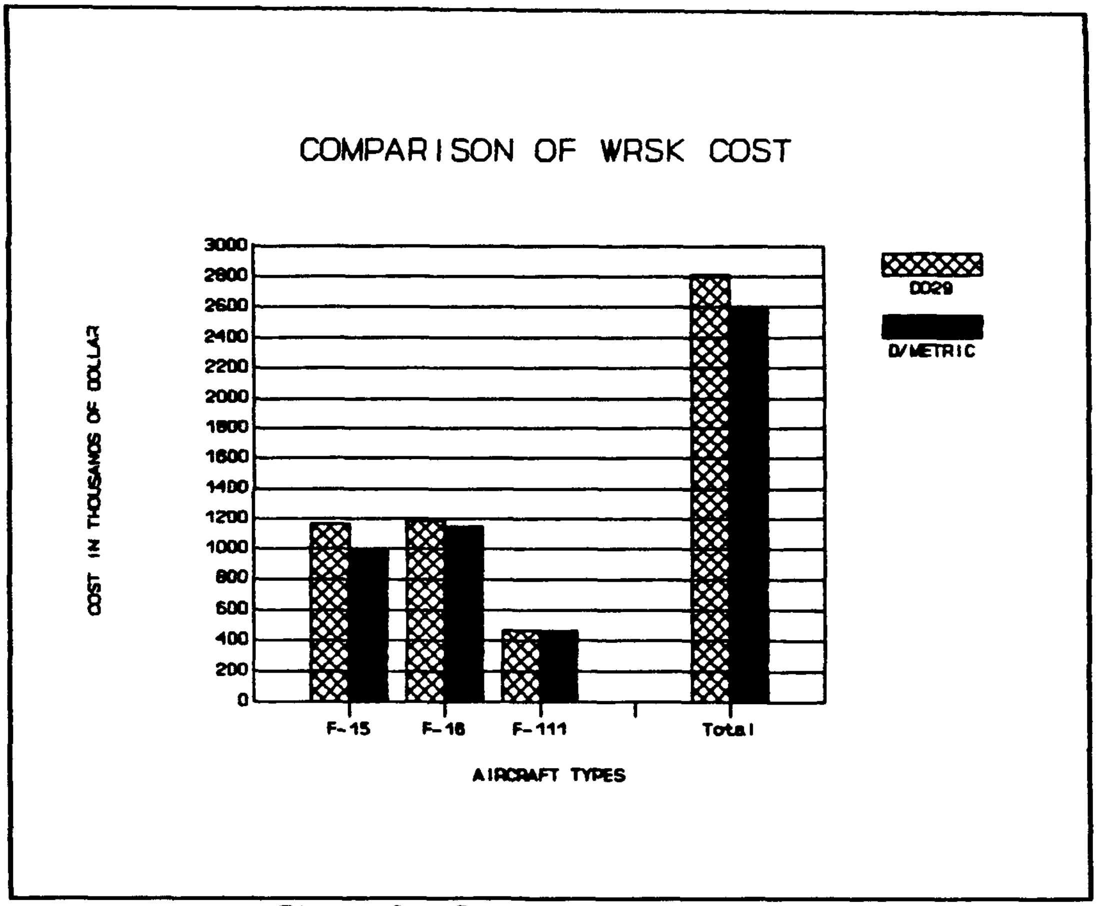


Figure 2. Comparison of WRSK cost.

Apart from its impact on costs, the number of units per WRSK for each of the weapon systems decreased when computed by Dyna-METRIC when compared to the D029 computations. The impacts on the number of units in each WRSK are given in Table 2 and the graph in Figure 3.

TABLE 2

COMPARISON OF WRSK DEPTH

Weapon System	Authorized Buy Kits	Number of Units (D029)	Number of Units D/METRIC	Total Reduction	Percent Reduction Per Kit
F-15	23	49,384	43,203	6,171	12.5%
F-16	32	85,458	71,538	13,920	16.3%
F-111	6	12,947	11,098	1,849	14.3%
Total	61	147,779	125,839	21,940	14.8%

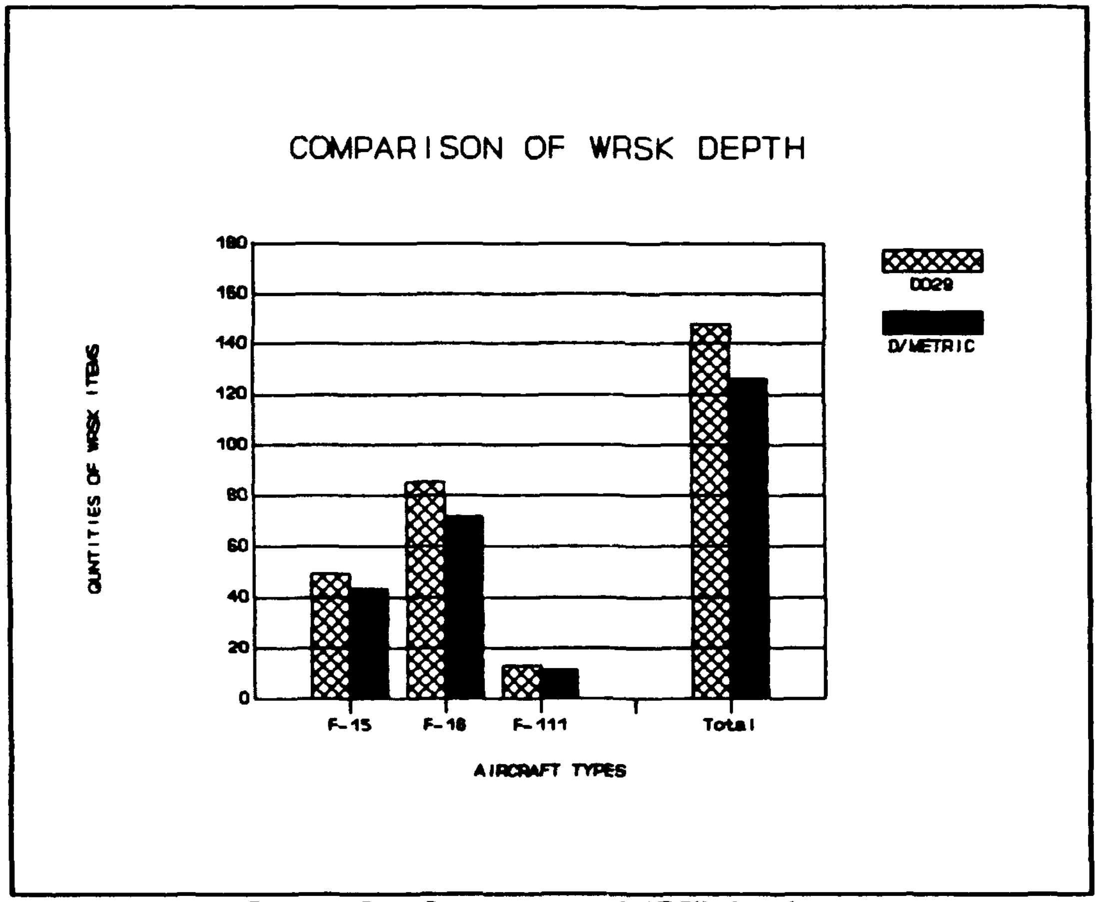


Figure 3. Comparison of WRSK depth

The specific advantages of Dyna-METRIC as summarized in the AFLC report are:

> Dyna-METRIC accurately considers indenture relationships and maximizes aircraft availability. By considering the indenture structure, Dyna-METRIC accurately models the impact of Shop Replaceable Units (SRUs) availability on the Line Replaceable Units (LRUs). The previous system's algorithm treated all SRUs as LRUs, thereby unnecessarily stocking SRU's when their parent LRUs are available. In addition, Dyna-METRIC uses an aircraft availability function to minimize the cost of achieving fewer grounded aircraft than the Direct Support objective. The previous system minimized a weighted average of back orders and grounded aircraft, so it did not find the least mix of items to meet the aircraft availability goal. (11:2)

Use on Microcomputers

Background. Dynamics Research Corporation (DRC) published a User's Manual for using Dyna-METRIC on microcomputers. (3:CH 1, P1) This manual is a detailed guide for the Dyna-METRIC Microcomputer Analysis System (DMAS) Version 3.1. Based on the initial technical specifications for DMAS provided by Headquarters Tactical Air Command (HQ TAC), the DRC made two improvements in March and July, 1988. These increments made DMAS capable of allocating base-wide sources of on-hand stock which could now be extracted from the Standard Base Supply System (SBSS). Now, it was also possible to load, edit, and execute Version 4.4 files from the mainframe computer Dyna-METRIC (3:CH 1, P1).

New DMAS Version 3.1 Features. DMAS Version 3.1 incorporates all the capabilities of DMAS Versions 1.0 and 2.1 and adds several new features. The principle new features include:

> (1) Standard Capability Assessment and Standard Deployment Computation--Most user settings are preselected and minimal input is required from the user. Also, this feature automatically prints standard DMAS 3.1 output reports.

(2) Automated Batch Printing of Output Reports--one can select the desired output reports and graphs, then leave the system unattended until all the output has been printed.

(3) Data Base Reporting--one can create formatted reports of data stored in the unit level data base.
(4) Deployment Computation Option--one can perform marginal analysis with either cost or criticality as the basis. Also, one may optionally exclude Non-Optimized (NOP) items from the computation. (3: CH1, P2)

DMAS Application. The primary DMAS applications include: Commander's Assessment (unit's wartime sortie capability), Peacetime Assessments (peacetime sortie capabilities that are supported by available Base spares sources), Deployment Computations (spares requirement for unit deployment) and Data Source Auditing (cross checks parts data loaded into DMAS from different sources) (3:CH 1, P2 to 4).

DMAS System Overview. Like any other computer model, the organization of DMAS can be well explained by examining its three main parts: inputs, functions and outputs. DMAS is quite flexible, its interactive menu system being integrated with a specialized unit-level database for the systems operation. The database used with DMAS is capable of holding a maximum of data on four bases or units at any one time. Figure 4 provides a system overview of DMAS. DMAS uses WSMIS/SAM and SBSS databases as inputs. Weapon System Management Information System Availability Module (WSMIS/SAM) generated files contain scenario data, parts data, and authorized stock levels in a format similar to the one of the standard Dyna-METRIC Version 4.4. The source of SBSS stock data is, of course, the SBSS of the concerned bases. The SBSS file contains data such as War Reserve Material (WRM), Peacetime Operating Stock (POS), Forward Supply Point Stock (FSP), and Due-In From Maintenance - Awaiting Parts Stock (DIFM-AWP) (3:CH 2, P1 to 2).

DMAS provides the following six major functions:

(1) creating and selecting a data base to be used during an analysis section;

(2) Loading scenario, parts, and stock data extracted from WSMIS/SAM and SBSS into the database;

(3)Editing data through a series of formatted screens;

(4) Performing capability assessments using Dyna-METRIC Version 4.4;

(5) Performing Deployment Computations using Dyna-METRIC Version 4.4;

(6) Viewing and printing output products generated from capability assessments, deployment computations, and the auditing processes (3:CH 2, P3).

The outputs generated by DMAS operations can either be viewed or printed to suit the user's requirements. The outputs are in the form of reports and graphs. There are four categories of DMAS outputs:

(1) Capability Assessment Reports and Graphs;

(2) Deployment Computations Reports;

(3) Data Source Audit Report; and

(4) Total Base Stock Report. (3:CH 2, P6)

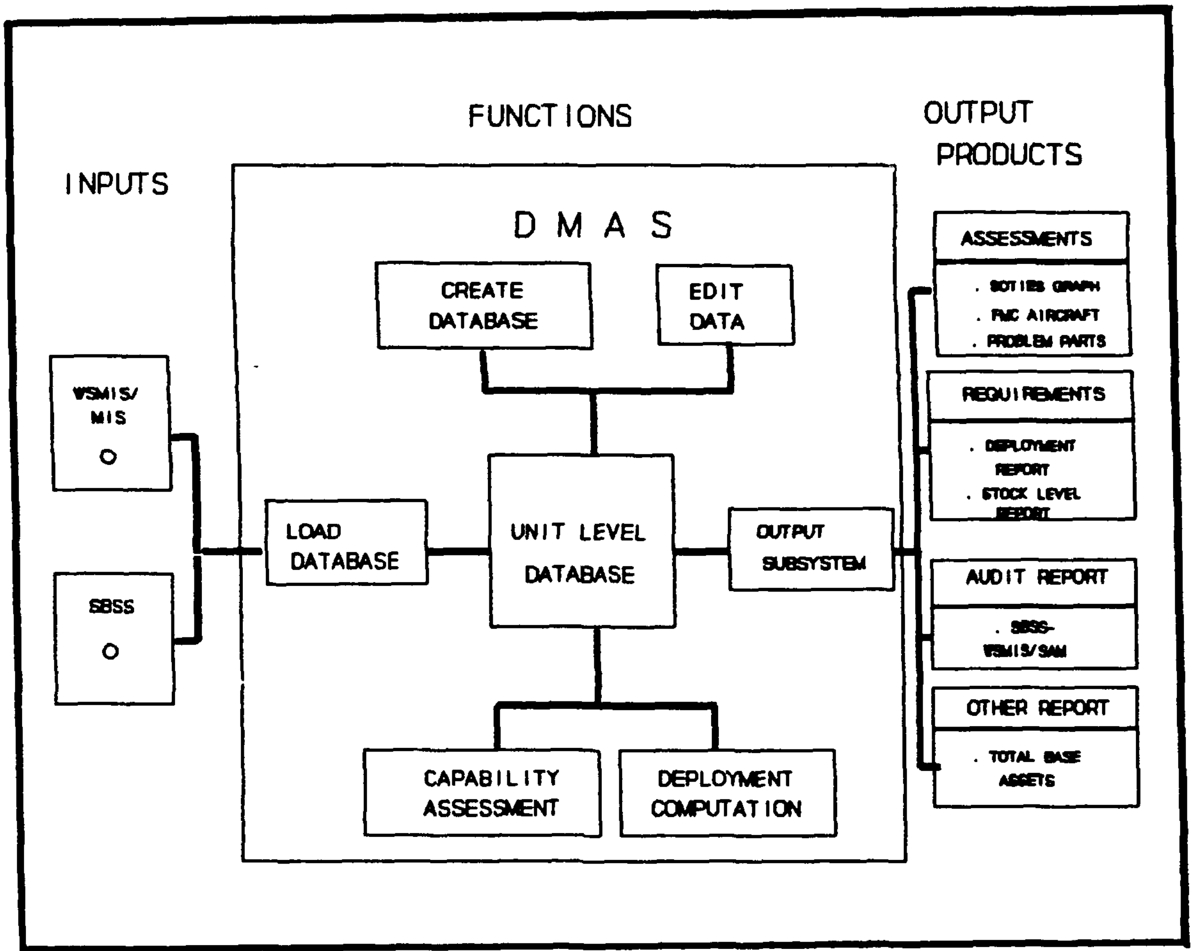


Figure 4. DMAS System Overview

III. Methodology

Overview

The purpose of this research was to compare two FOB Mobilization Reserve Kits for PAF F-16 aircraft built by two separate computation techniques. At present, PAF Deployment kits are computed by employing a mix of manual as well as computer-based methods. The decision to include a particular range of items and particular level of those items in the kit is reflective of both the maintainers' perception of future consumption pattern and funds availability. It was necessary to develop a research procedure in order to apply Dyna-METRIC to evaluate the PAF Kit. The methodology developed for this research consisted of three ingredients. These were; use of a model, scenario/database, and formation of an experimental design/procedure.

The Model

As is evident from the research topic, the use of the Dyna-METRIC inventory model, due to its capabilities already described in Chapter II, was pre-selected. However, the literature review revealed availability of Dyna-METRIC Microcomputer Analysis System (DMAS) to be a suitable tool by virtue of its convenient utilization on the personal computers. Application of DMAS to demonstrate appropriateness of Dyna-METRIC for PAF F-16 FOB Kit effectiveness warranted acquisition of the scenario/database and setting up of a logical experimental design. These issues are dealt with in detail in the succeeding paragraphs.

Scenario and Database

PAF Air Headquarters, Project Falcon, provided the scenario and database for this research. No. 120 Air Logistics Depot, PAF, provided itemized listings of the F-16 FOB Mobilization Deployment Kit. Wing Commander Asif M. Malik, Deputy Project Director for Logistics (Project Falcon) was instrumental in passing information needed for this research by FAX through the PAF F-16 Liaison officer at Ogden Air Logistics Center (ALC) Utah, and the Pakistan Country Manager at the International Logistics Center (ILC), Wright-Patterson Air Force Base, Ohio. In addition, USAF WRSK data, available at AFIT for training purposes, was manipulated to meet the requirements of this research.

Scenario.

The PAF compute their Deployment Kit levels based on varying number of aircraft in each deployment configuration. For instance, the spares levels are marked for planned deployments of ten, twenty, and thirty aircraft. The information provided by No. 120 ALD was computed for a ten F-16 aircraft configuration planned to be deployed for a period of 30 days.

Database.

Staying within the scope of this study, the research was restricted to reparable components (XD2). The F-16's versatility lends itself to the use of the aircraft in a variety of roles within a theater of operations. The types of missions flown could be interception, Combat Air Patrol (CAP), interdiction, offense, and air defense. The aircraft sortie duration, therefore, ranges from one to two-and-half hours depending on the type of mission flown. The PAF recommended an average

sortie length of one-and-one-half hours. They also recommended that the computations should be based on an aircraft utilization rate of two sorties per aircraft per day, for the operations extendable to a period of thirty days. Therefore, given the foregoing scenario, a group of ten aircraft was expected to generate a total of 600 sorties throughout a 30-day long operation, provided aircraft losses due to battle attrition are presumed to be zero.

Research Procedure

After acquiring Deployment Kit Data from Project Falcon, Air Headquarters, Pakistan, the first step was to physically eliminate the XB3 items from the list. This was done to conform to the USAF WRSK data, as well as to meet requirements of the computer model applied. DMAS is basically designed to handle XD2 items only. The next step was to scrutinize the PAF Kit in order to find those XD2 items that matched the USAF WRSK items' stock numbers already available in the database. Seventy five items were finally selected to be used as a representative sample of the PAF Kit.

Prior to using DMAS, there were two choices available for use of the FOB Kit database obtained from Pakistan: First, to create this new database afresh in DMAS; or second, to utilize the USAF F-16 database that already existed. It was obviously much more convenient to use the second option wherein creation of the database was not required. Instead, this process allowed manipulation of the existing database by way of setting the application fraction of all non-essential items to zero.

The DMAS model was run on Capability Assessment as well as on Deployment Computation mode. Initially, the model was run on Capability Assessment mode against the PAF authorization of the 75 items in the initial kit to determine supportability of the planned mission in terms of daily sorties generation and availability of FMC aircraft throughout the duration of the exercise. The model was later run on Deployment Computation mode to establish kit levels required to provide optimum support to the planned task of 600 sorties at the rate of 2 sorties per day per aircraft for a 30-day long operation of 10 aircraft. Based on this model run, parts with no demand were deleted from further analysis. This reduced the model's computation time without impact on results.

A spread sheet was generated to determine the total cost of the seventy-five reparable items of the PAF Kit. Table 3 in the next Chapter lists, by National Stock Numbers (NSNs), and cost of these items as it appeared in the USAF Kit. The stock levels for all the items, as received from the PAF, are also indicated in the table. In order to enhance the support capability of the initial PAF kit, without incurring extra expenditure, the amount saved by eliminating the 25 not-required items was to be utilized to increase level of the items in the kit. The Problem Parts Report available as one of the DMAS options generated a list of the top five Problem Parts. This report provided a guide for the selection of items required to be added to the kit. Within the limited amount available, not all, but only a few items could be purchased and added to the kit. The substitution was limited to the first three items in different quantities. Results of the computer runs and their detailed analysis are given in the following chapter.

IV. Results and Analysis

Overview

Each Dyna-METRIC run generates a variety of outputs that can be used as a whole or as specified by the user by selecting menu options. The evaluation is based on a pre-selected degree of confidence, which can also be pre-determined. An increase or decrease in the confidence level will correspondingly produce results relevant in that particular perspective only. The partial or full-cannibalization assumption can also be applied as necessary.

The kit's supportability depends on correct determination of levels of the right items in the right quantities. How well this objective was met was best illustrated by the Dyna-METRIC outputs that provided probability of daily FMC aircraft availability and sorties generation per day. In addition to the daily sorties and FMC aircraft reports, another useful report containing top five Problem Parts was also generated. This report assisted greatly in identifying areas which needed immediate attention and could impact availability of FMC aircraft that could eventually result in higher sortie-rate.

PAF Kit Analysis

The description of parts, their costs and the levels of the 75 items of the initial PAF Kit are given in Table 3. The results produced by the DMAS run based on the representative sample of the current deployment kit levels gave 7.88 (39.40%) against 20 tasked sorties and 2.63 (26.30%) against a total of 10 FMC aircraft on the thirtieth day of operations.

TABLE 3

PAKISTAN AIR FORCE

INITIAL DEPLOYMENT KIT

S No	NSN	Auth qty	Unit Cost (Dollars)	Total Cost (Dollars)
1	1005010463536	1	15380.00	15380.00
2	1270010453976	1	62679.00	62679.00
3	1270010609052	1	3482.00	3482.00
4	1270010932256	1	85149.00	85149.00
5	1270010946872	1	15666.00	15666.00
6	1270011022966	1	147335.00	147335.00
7	1270011229955	1	53392.00	53392.00
8	1270011336494	1	108835.00	108835.00
9	1270011464630	2	109893.00	219786.00
10	1280011091499	1	8991.00	8991.00
11	1620011365173	1	923.00	923.00
12	1630008521432	3	772.00	2316.00
13	1630010824733	1	1506.00	1506.00
14	1630011184492	1	3195.00	3195.00
15	1630011996430	2	6167.00	12334.00
16	1630012173141	1	849.00	849.00
17	1650011061594	1	30236.00	30236.00
18	1650011657203	1	30529.00	30529.00
19	1650012223790	1	38831.00	38831.00
20	1660010525354	1	1928.00	1928.00
21	1660010575182	1	2428.00	2428.00
22	1660011072459	1	9399.00	9399.00
23	1680010510534	1	2507.00	2507.00
24	1680010841544	1	1568.00	1568.00
25	1680011295207	1	6283.00	6283.00
26	2835010738989	1	7789.00	7789.00
27	2835011156111	1	3351.00	3351.00
28	2835011543533	1	23690.00	23690.00
29	2910011355681	1	6971.00	6971.00
30	2915010414481	1	10918.00	10918.00
31	2915010924448	1	771.00	771.00
32	2915011793834	1	2149.00	2149.00
33	2925011150306	2	13487.00	26974.00
34	2995010608514	2	236.00	472.00
35	4810010996392	1	4326.00	4326.00
36	4810011237254	1	2796.00	2796.00
37	4810011307379	1	4003.00	4003.00
38	4810012257171	1	3296.00	3296.00
39	4820011107775	1	835.00	835.00
40	5821010687854	2	6524.00	13048.00
41	5826010121938	1	12006.00	12006.00

(Continued)

TABLE 3 (Continued)

S No	NSN	Auth qty	Unit Cost (Dollars)	Total Cost (Dollars)
42	5826010409798	1	8634.00	8634.00
43	5826010485194	1	816.00	816.00
44	5826010759774	1	1096.00	1096.00
45	5831006232912	1	542.00	542.00
46	5841010963945	1	29870.00	29870.00
47	5841010964833	1	37080.00	37080.00
48	5865010920386	1	1619.00	1619.00
49	5865011074586	1	1945.00	1945.00
50	5865011106043	1	38159.00	38159.00
51	5865011265699	1	9058.00	9058.00
52	5865011549125	1	7448.00	7448.00
53	5895011126380	2	21714.00	43428.00
54	6110010385065	1	3112.00	3112.00
55	6110011082690	2	2269.00	4538.00
56	6130010517518	2	3647.00	7294.00
57	6605010146353	1	27810.00	27810.00
58	6605010784943	1	12622.00	12622.00
59	6605010876645	1	145487.00	145487.00
60	6610002008832	1	4150.00	4150.00
61	6610010891018	1	16155.00	16155.00
62	6610010929846	1	4614.00	4614.00
63	6610011230046	1	21865.00	21865.00
64	6610012226439	1	2271.00	2271.00
65	6615010427834	1	3623.00	3623.00
66	6615011273160	1	11345.00	11345.00
67	6615011297445	1	2554.00	2554.00
68	6615011496398	1	15990.00	15990.00
69	6615011611592	1	53835.00	53835.00
70	6620010606418	1	2837.00	2837.00
71	6645000763050	1	562.00	562.00
72	6680009763923	1	787.00	787.00
73	6680010604248	1	4712.00	4712.00
74	6680010722799	1	1931.00	1931.00
75	6680010749369	1	4012.00	4012.00
			Total	1520723.00 (1.52M)

Figures 5 and 6 represent sorties and FMC aircraft reports resulting from the aforesaid run. The sorties and the FMC aircraft availability graphs show a steep drop following the tenth day of the operations. Ten aircraft flown at the rate of two sorties per aircraft

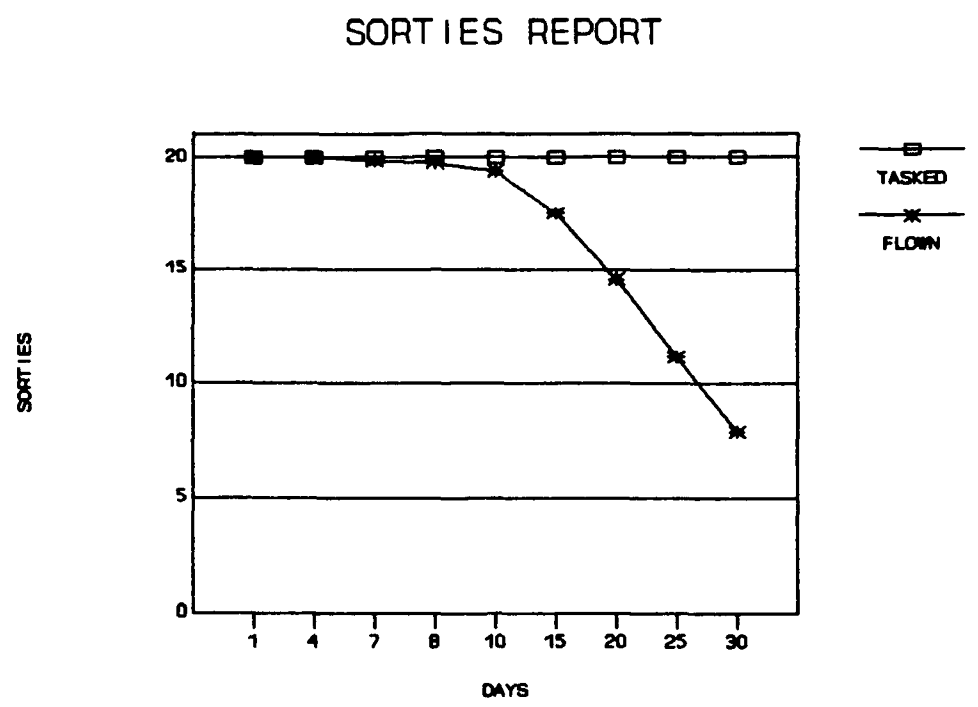


Figure 5. Sorties-Generation Supported by Initial PAF Kit

per day will theoretically generate 600 sorties in a 30-day period of operations. With this target tasking of 600 sorties required to be accomplished in 30 days, the model was run on the Deployment Computation mode to identify parts and their levels needed to build a kit to obtain optimum support. The levels thus computed by the model are given in Table 4. The graphs in Figures 7 and 8 show that enough support was provided by this kit to generate 19.27 (96.35%) against 20 tasked

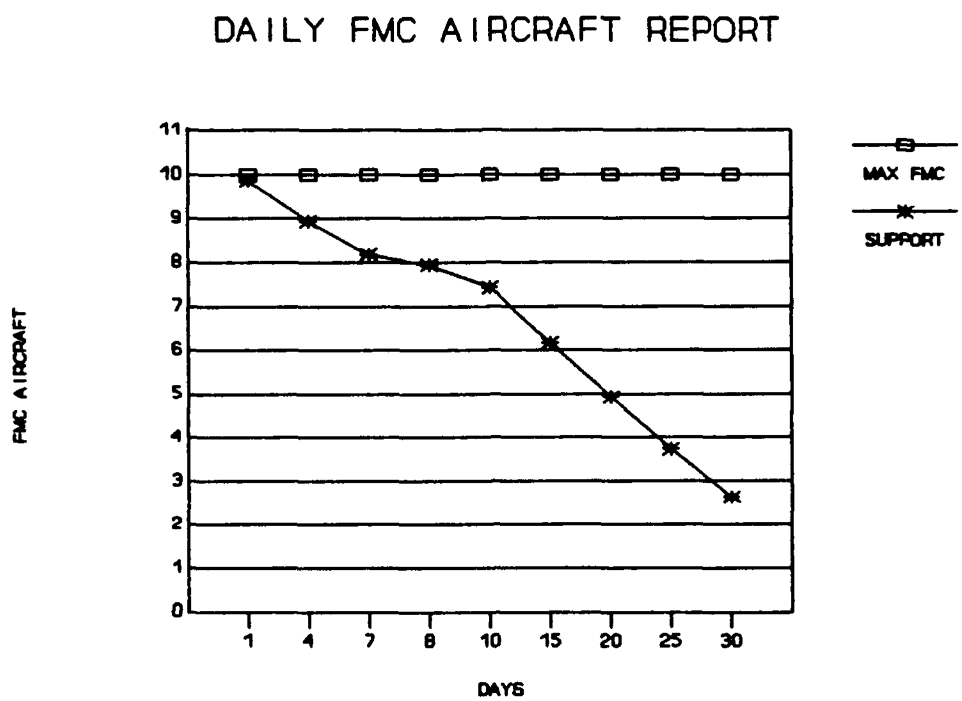


Figure 6. FMC Aircraft Availability Based on Initial PAF Deployment Kit

sorties and 7.2 (72.00%) FMC aircraft availability against the total strength of 10 aircraft. It may be noted from Table 4 that it costs $3.80 million to achieve about 96 percent of sortie-rate per day and the probability of getting 72 percent FMC aircraft on the thirtieth day of operations.

It was discovered that the kit currently being used by the PAF had two problems: first, the stock levels were very low, and second, some 25 items with no expected demand were also included in the kit.

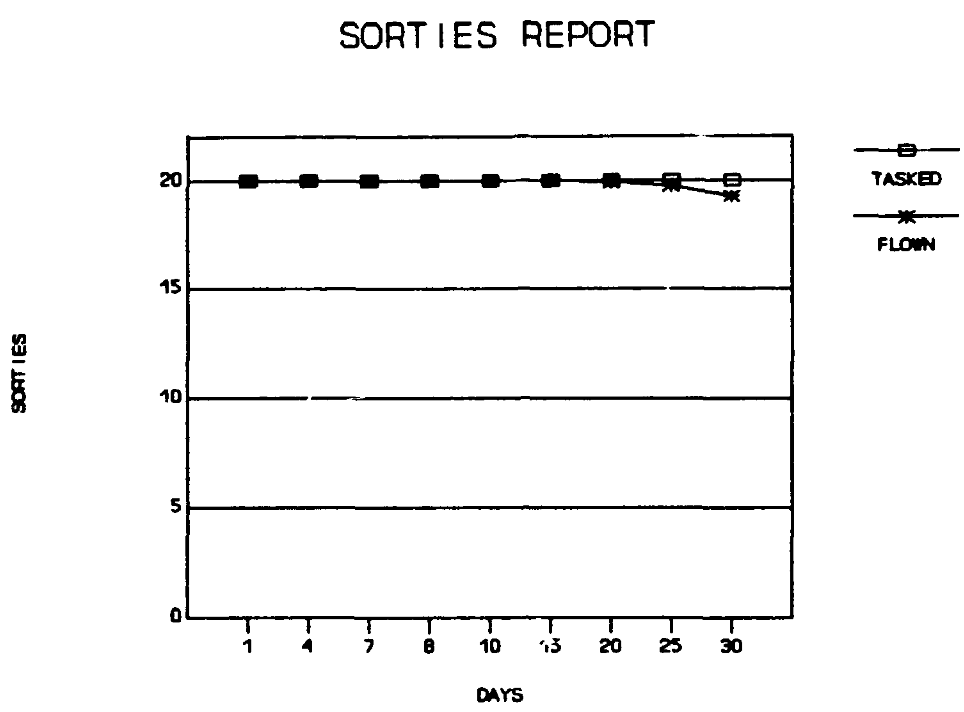


Figure 7. Sortie-Rate Computed By Dyna-METRIC Model

This implied that the PAF kit could be reduced by twenty five parts with no impact on the support. The prices and current stock levels of the 50 items are given in Table 5.

Validation. The preceding assumption was tested by executing two model runs with the 50-parts and the 75-parts kit. The expected support from these two runs, in terms of sorties and FMC aircraft availability, turned out to be exactly similar. A comparison of the output generated by the two kits is presented here for a ready reference.

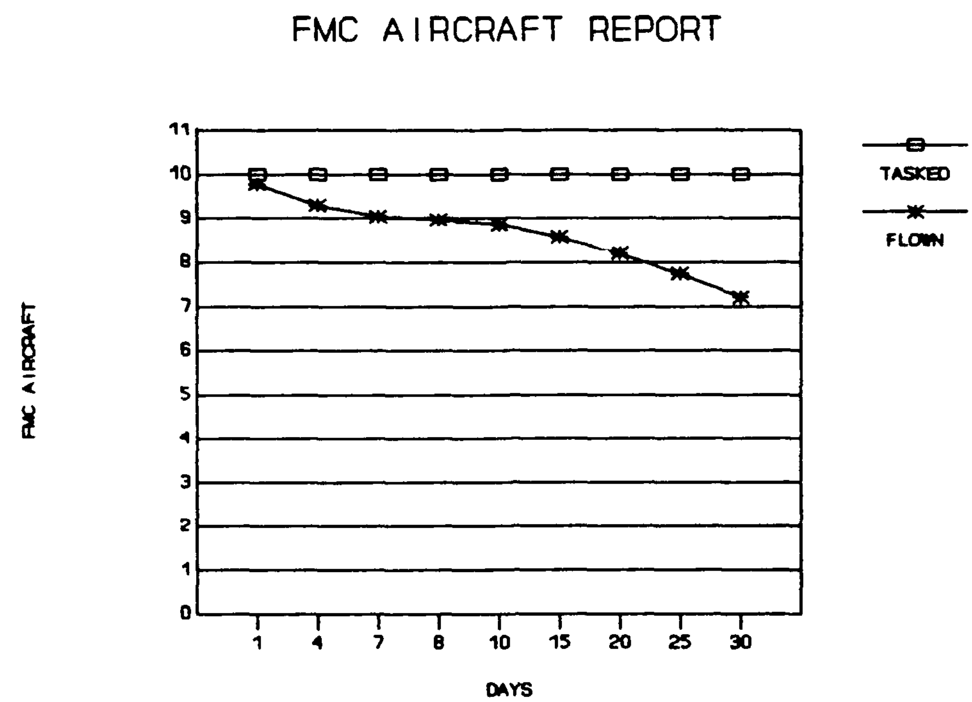


Figure 8. FMC Aircraft Availability Based on Dyna-METRIC Calculated Kit

<u>Comparison of The Support Provided by Initial Kit</u>

<u>and The DMAS computed Kit</u>

	Outputs	
Number of Items/Kit	Sorties	NMC Aircraft
75	7.88(39.40%)	2.63(26.30%)
50	7.88(39.40%)	2.63(26.30%)

Graphs of the sorties report and the daily FMC aircraft report generated by the 50 item kit are given in Figures 9 and 10. It is

pertinent to note the graphs in Figures 5 and 6 representing support by the 75-item kit are identical to those in Figures 9 and 10 showing the 50-item kit support.

TABLE 4
DYNA-METRIC COMPUTED STOCK REPORT

S No	NSN	Unit Cost (Dollars)	Quantity Required	Total Cost (Dollars)
1	1005010463536	15380.00	6	92280.00
2	1270010453976	62679.00	3	188037.00
3	1270010932256	85149.00	2	170298.00
4	1270010946872	15666.00	1	15666.00
5	1270011229955	53392.00	3	160176.00
6	1270011336494	108835.00	2	217670.00
7	1270011464630	109893.00	4	439572.00
8	1280011091499	8991.00	8	71928.00
9	1620011365173	923.00	1	923.00
10	1630008521432	772.00	7	5404.00
11	1630010824733	1506.00	1	1506.00
12	1630011996430	6167.00	2	12334.00
13	1650011061594	30236.00	1	30236.00
14	1650011657203	30529.00	3	91587.00
15	1650012223790	38831.00	3	116493.00
16	1660010575182	2428	1	2428.00
17	1660011072459	9399	2	18798.00
18	1680010510534	2507	7	17549.00
19	2995010608514	236	2	472.00
20	4810011237254	2796	1	2796.00
21	4810011307379	4003	1	4003.00
22	5821010687854	6524	8	52192.00
23	5826010121938	12006	3	36018.00
24	5826010759774	1096	1	1096.00
25	5841010963945	29870	3	89610.00
26	5841010964833	37080	2	74160.00
27	5865010920386	1619	13	21047.00
28	5865011074586	1945	1	1945.00
29	5865011106043	38159	1	38159.00
30	5865011549125	7448	3	22344.00
31	5895011126380	21714	7	151998.00
32	6110010385065	3112	1	3112.00
33	6110011082690	2269	2	4538.00
34	6130010517518	3647	7	25529.00
35	6605010146353	27810	5	139050.00
36	6605010784943	12622	1	12622.00

(Continued)

Table 4 (Continued)

37	6605010876645	145487	8	1163896.00
38	6610002008832	4150	1	4150.00
39	6610010891018	16155	3	48465.00
40	6610010929846	4614	1	4614.00
41	6610011230046	21865	3	65595.00
42	6610012226439	2271	1	2271.00
43	6615010427834	3623	1	3623.00
44	6615011273160	11345	2	22690.00
45	6615011297445	2554	2	5108.00
46	6615011611592	53835	2	107670.00
47	6620010606418	2837	2	5674.00
48	6645000763050	562	5	2810.00
49	6680009763923	787	4	3148.00
50	6680010749369	4012	2	8024.00
		Total		3781314.00
				($3.80M)

Improved Management of The PAF Kit

At this point, the main research objective was achieved. However, there was a possibility of effecting further improvement in the PAF Kit. It was decided to broaden the scope of research by further analyzing the underlying recommendations of DMAS, and by utilizing its other outputs for more efficient kit management.

TABLE 5

THE RATIONALIZED PAF KIT

S No	NSN	Qty Auth	Unit Cost (Dollars)	Total Cost (Dollars)
1	1005010463536	1	15380.00	15380.00
2	1270010453976	1	62679.00	62679.00
3	1270010932256	1	85149.00	85149.00
4	1270010946872	1	15666.00	15666.00
5	1270011229955	1	53392.00	53392.00

(Continued)

Table 4 (Continued)

6	1270011336494	1	108835.00	108835.00
7	1270011464630	2	109893.00	219786.00
8	1280011091499	1	8991.00	8991.00
9	1620011365173	1	923.00	923.00
10	1630008521432	3	772.00	2316.00
11	1630010824733	1	1506.00	1506.00
12	1630011996430	2	6167.00	12334.00
13	1650011061594	1	30236.00	30236.00
14	1650011657203	1	30529.00	30529.00
15	1650012223790	1	38831.00	38831.00
16	1660010575182	1	2428.00	2428.00
17	1660011072459	1	9399.00	9399.00
18	1680010510534	1	2507.00	2507.00
19	2995010608514	2	236.00	472.00
20	4810011237254	1	2796.00	2796.00
21	4810011307379	1	4003.00	4003.00
22	5821010687854	2	6524.00	13048.00
23	5826010121938	1	12006.00	12006.00
24	5826010759774	1	1096.00	1096.00
25	5841010963945	1	29870.00	29870.00
26	5841010964833	1	37080.00	37080.00
27	5865010920386	1	1619.00	1619.00
28	5865011074586	1	1945.00	1945.00
29	5865011106043	1	38159.00	38159.00
30	5865011549125	1	7448.00	7448.00
31	5895011126380	2	21714.00	43428.00
32	6110010385065	1	3112.00	3112.00
33	6110011082690	2	2269.00	4538.00
34	6130010517518	2	3647.00	7294.00
35	6605010146353	1	27810.00	27810.00
36	6605010784943	1	12622.00	12622.00
37	6605010876645	1	145487.00	145487.00
38	6610002008832	1	4150.00	4150.00
39	6610010891018	1	16155.00	16155.00
40	6610010929846	1	4614.00	4614.00
41	6610011230046	1	21865.00	21865.00
42	6610012226439	1	2271.00	2271.00
43	6615010427834	1	3623.00	3623.00
44	6615011273160	1	11345.00	11345.00
45	6615011297445	1	2554.00	2554.00
46	6615011611592	1	53835.00	53835.00
47	6620010606418	1	2837.00	2837.00
48	6645000763050	1	562.00	562.00
49	6680009763923	1	787.00	787.00
50	6680010749369	1	4012.00	4012.00
		Total		1223330.00
				($1.22M)

Before attempting to improve the PAF kit management, two facts needed to be closely looked at. First, $1.52M, the cost of the existing kit containing 75 items compared to $3.8M, the cost of the optimal kit. Second, $1.22M, the cost of the kit consisting of 50 items, that provided support equivalent to the initial kit. In case the optimal

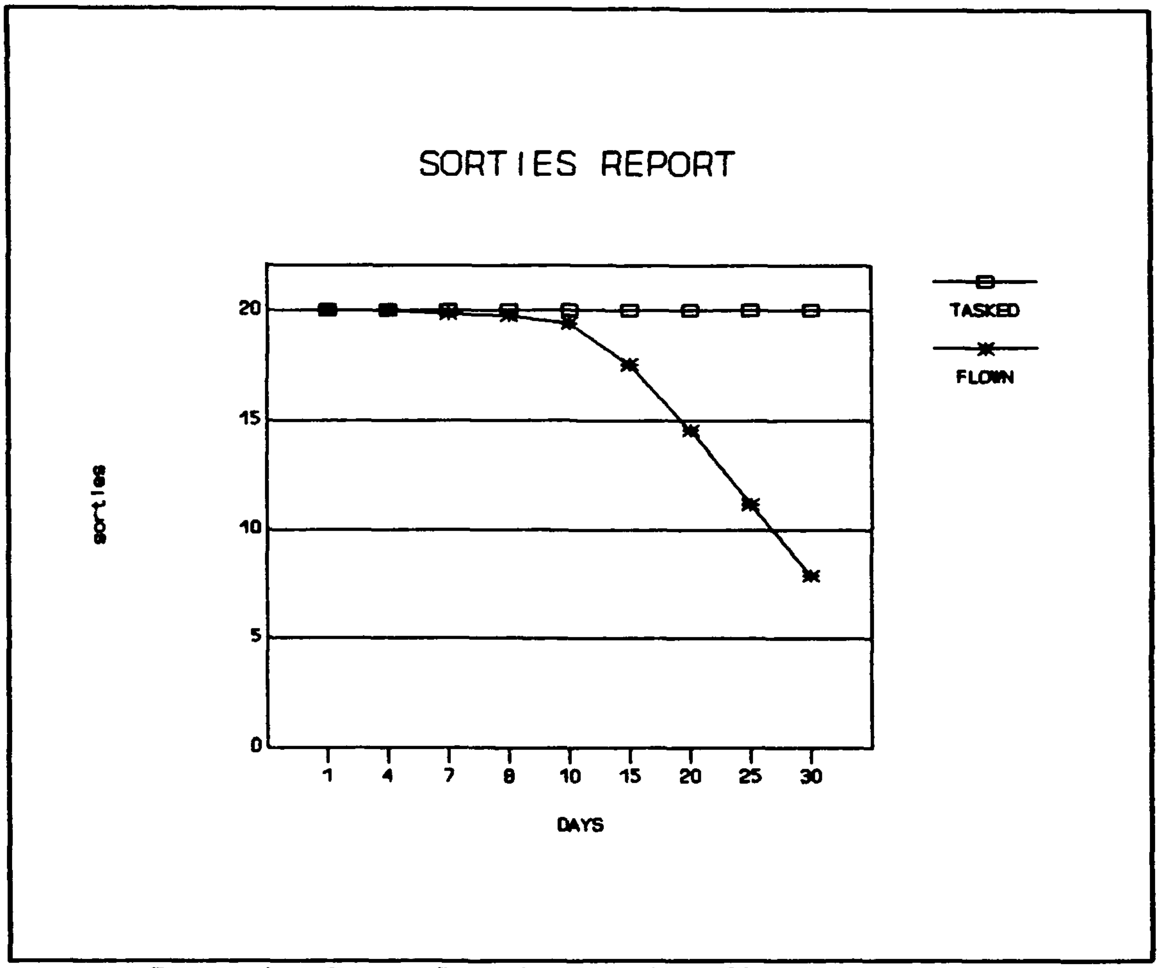
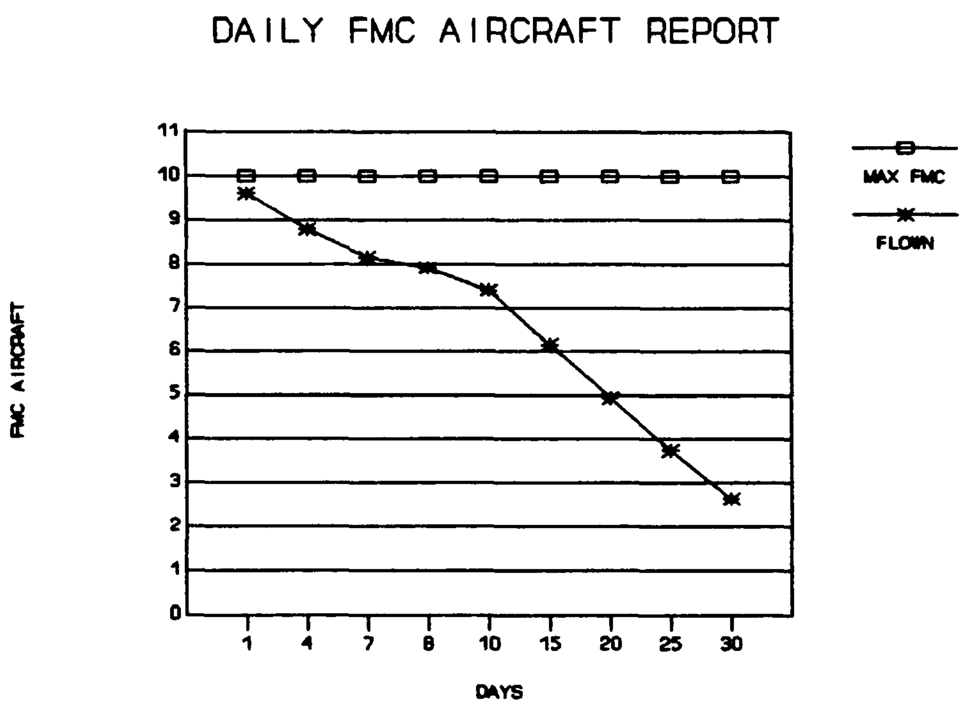


Figure 9. Sortie-Rate Generated by 50-Items Kit

kit, predicted to provide 96% sorties generation and 72% availability of FMC aircraft, was not affordable, DMAS could be applied to identify the alternate methods to improve the existing PAF kit.

Therefore, staying within the cost constraints, the existing kit was managed with greater efficiency and effectiveness by critically analyzing the outputs generated by the Dyna-METRIC model and by suitably implementing its underlying recommendations. The Problem Parts Report



Figur 10. FMC Aircraft Availability Based on Support Provided by 50-parts Kit

contained in Table 6, also shown in Figure 11, assisted in identifying the exact problem areas. The first five lines on the graph show the five Problem Parts ranked by the total number of grounded aircraft. The sixth line, however, indicates the maximum number of FMC aircraft.

About $297,000 was saved as a result of eliminating 25 no-demand parts from the initial kit. This money was applied to add additional quantities of the Problem Parts to the kit. As a result, performance of the kit improved without incurring extra costs.

TABLE 6

PROBLEM PARTS

No.	NSN	Cost Per Item	Quantities Required
1.	6605010876645	145,487.00	8
2.	5865010920386	1,619.00	13
3.	5895011126380	21,714.00	7
4.	1005010463536	15,380.00	6
5.	1680010510534	2,507.00	7

The total amount required to purchase the new parts was to be restricted to $297,000, the amount equivalent to the savings made as a result of the Dyna-METRIC computations. Due to this financial constraint it was not possible to add all the Problem Parts to bring their quantities in the kit to the optimum stock levels. The objective therefore was to find out the best mix of the quantities of these parts and add them to the kit in order to achieve greater supportability. This process involved study of the effects on the kit's supportability by incrementally adding different quantities of the Problem Parts.

It was considered essential to execute separate DMAS runs, obtain the outputs and compare and evaluate their results. This process afforded opportunity to the researcher to watch the improvement, when

parts were incrementally added to the kit, by subsequent analysis of outputs generated by these computer runs. All such computer generated outputs also indicated corresponding increases in the total costs of the ensuing kit caused by specific additions.

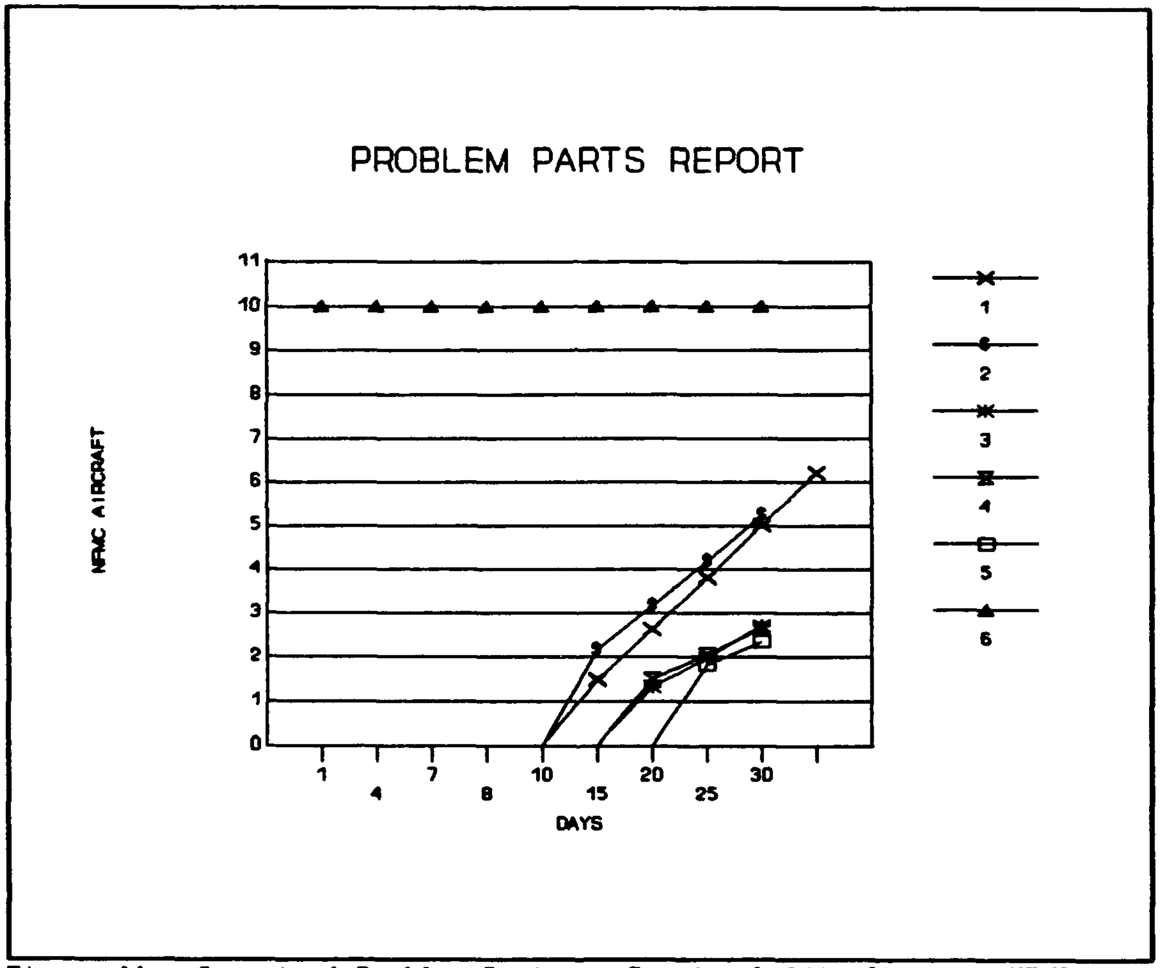


Figure 11. Impact of Problem Parts on Serviceability Shown as NFMC Aircraft

First Scenario

In this case, a quantity one of problem part #1 was added to the kit at an expenditure of #145,487, to bring its level to two. The output

increased to 8.95 (44.75%) sorties and FMC aircraft availabilityto 2.99 (29.90%) on day 30. The impact is graphically presented in Figures 12 and 13.

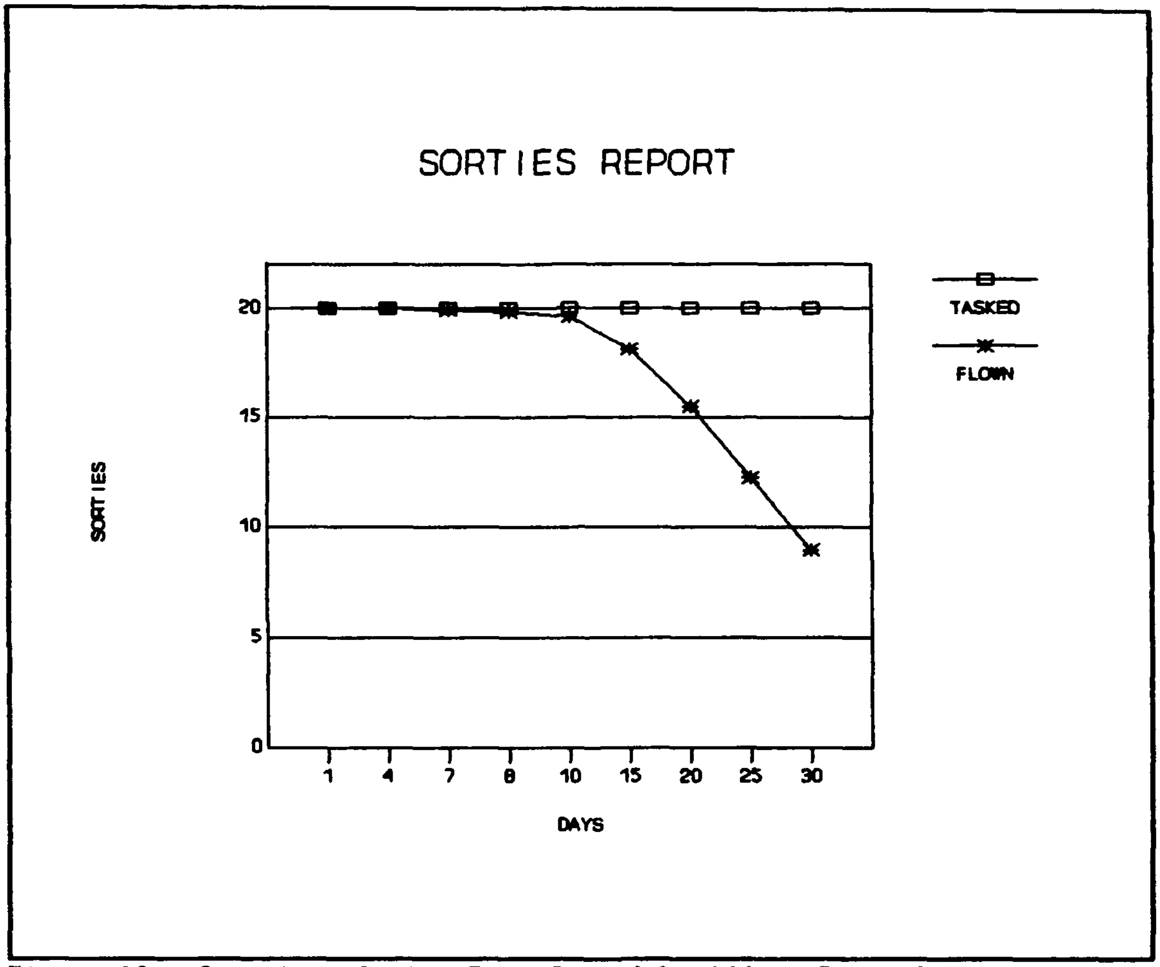


Figure 12. Impact on Sortie-Rate Caused by Adding Part #1 Qty one to the Kit

Second Scenario

In the 2nd case, another quantity one of Problem Part #1 was added to the kit, now costing $290,974 to raise its level to two. The output increased to 9.76 (48.80%) sorties and 3.26 (32.60%) FMC aircraft availability on day 30. Figures 14 and 15 show the rise in the outputs.

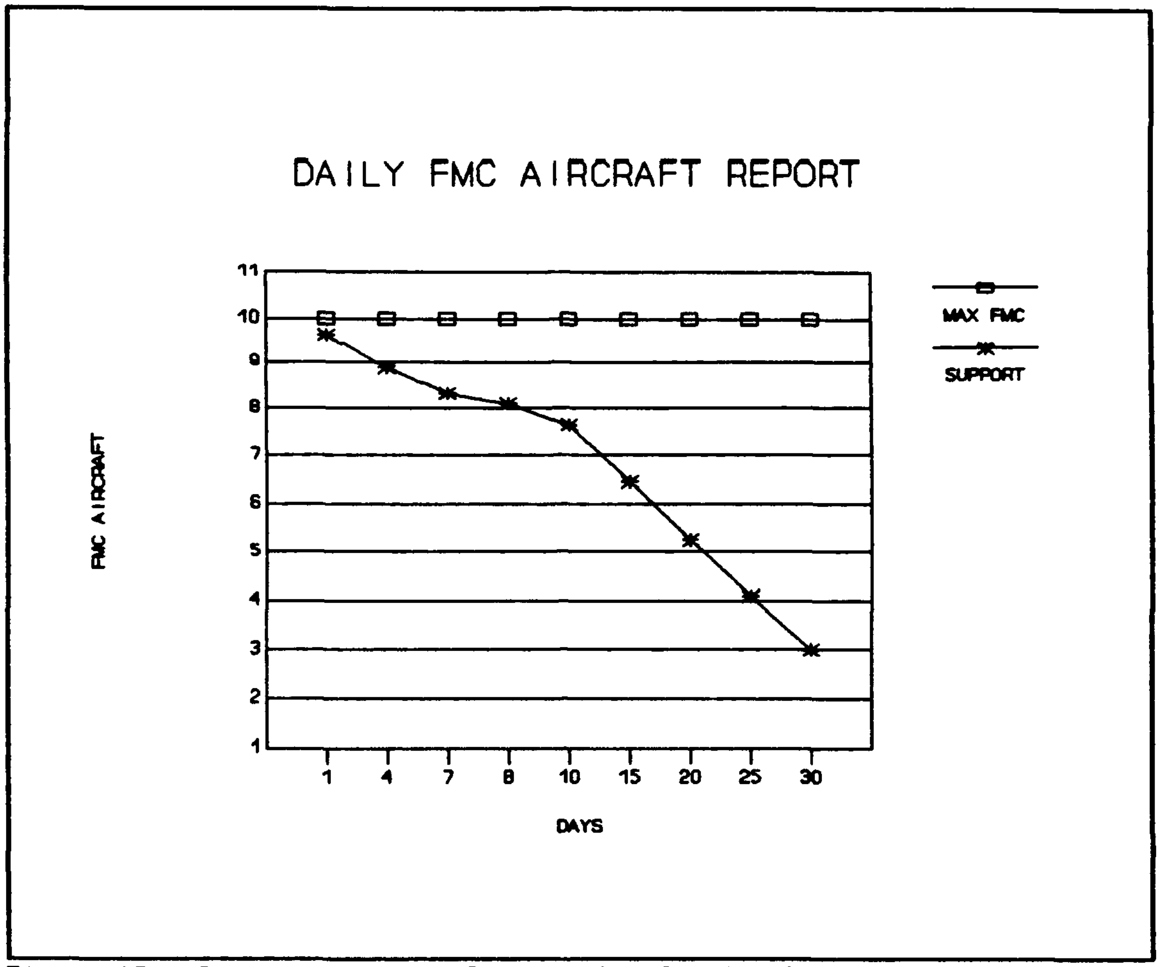


Figure 13. Impact of Adding Part #1 Qty One to the Kit on FMC Aircraft Availability

Third Scenario

In this case, parts #1, #2, and #3 were increased by quantities 1, 12, and 3 respectively. The levels of these parts correspondingly rose to 2, 15, and 5. $291,477 was spent to add these parts to the kit. The output increased to 9.85 (49.25%) sorties and 3.29 (32.90%) FMCaircraft availability on day 30. Figures 16 and 17 represent the increased outputs.

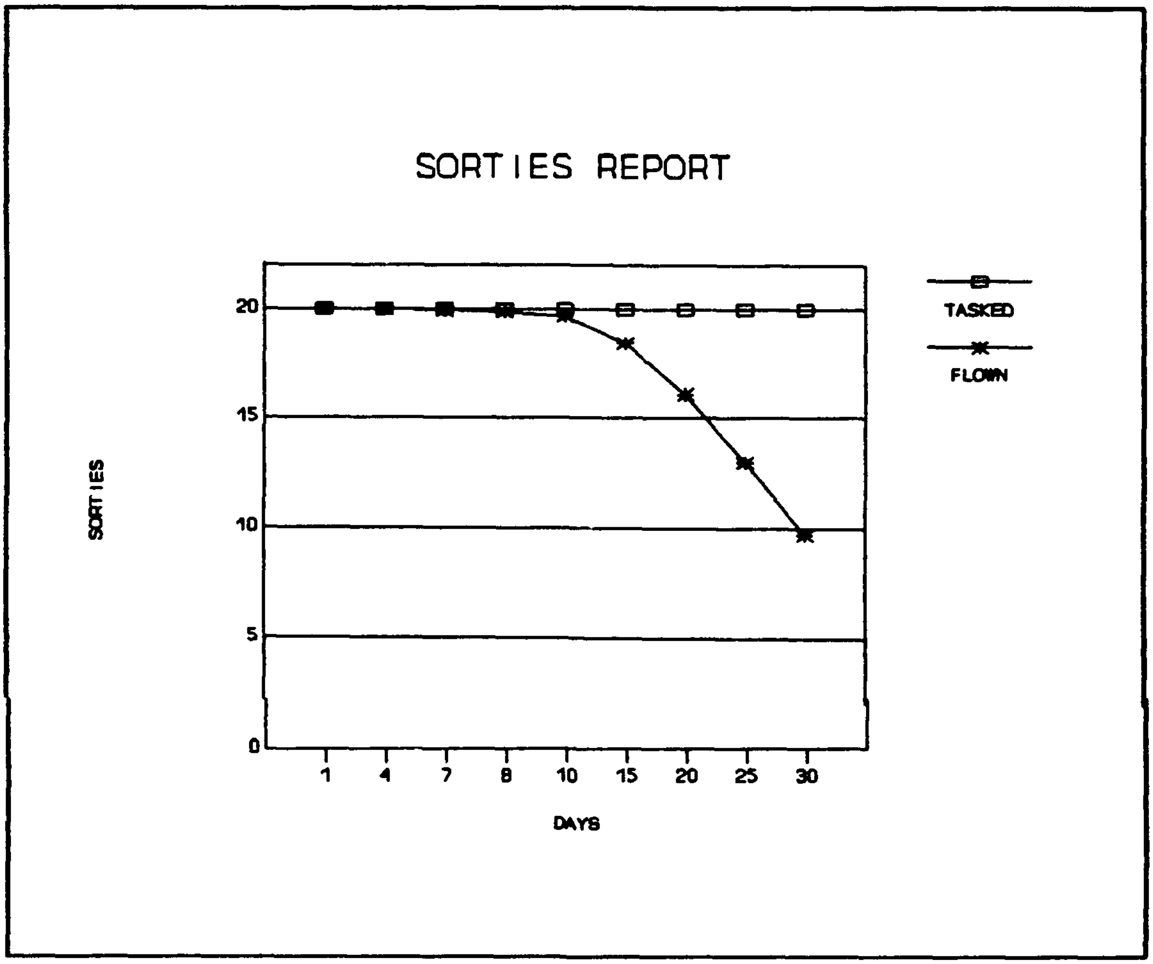


Figure 14. Impact of Adding Part #1 Qty Two to the Kit on Sortie-Rate

With no more funds available, the process was terminated at this point. A consolidated picture of the kit under different arrangements, based on their contents and costs is given in Table 7 to facilitate the reader's understanding of all the scenarios in one glance.

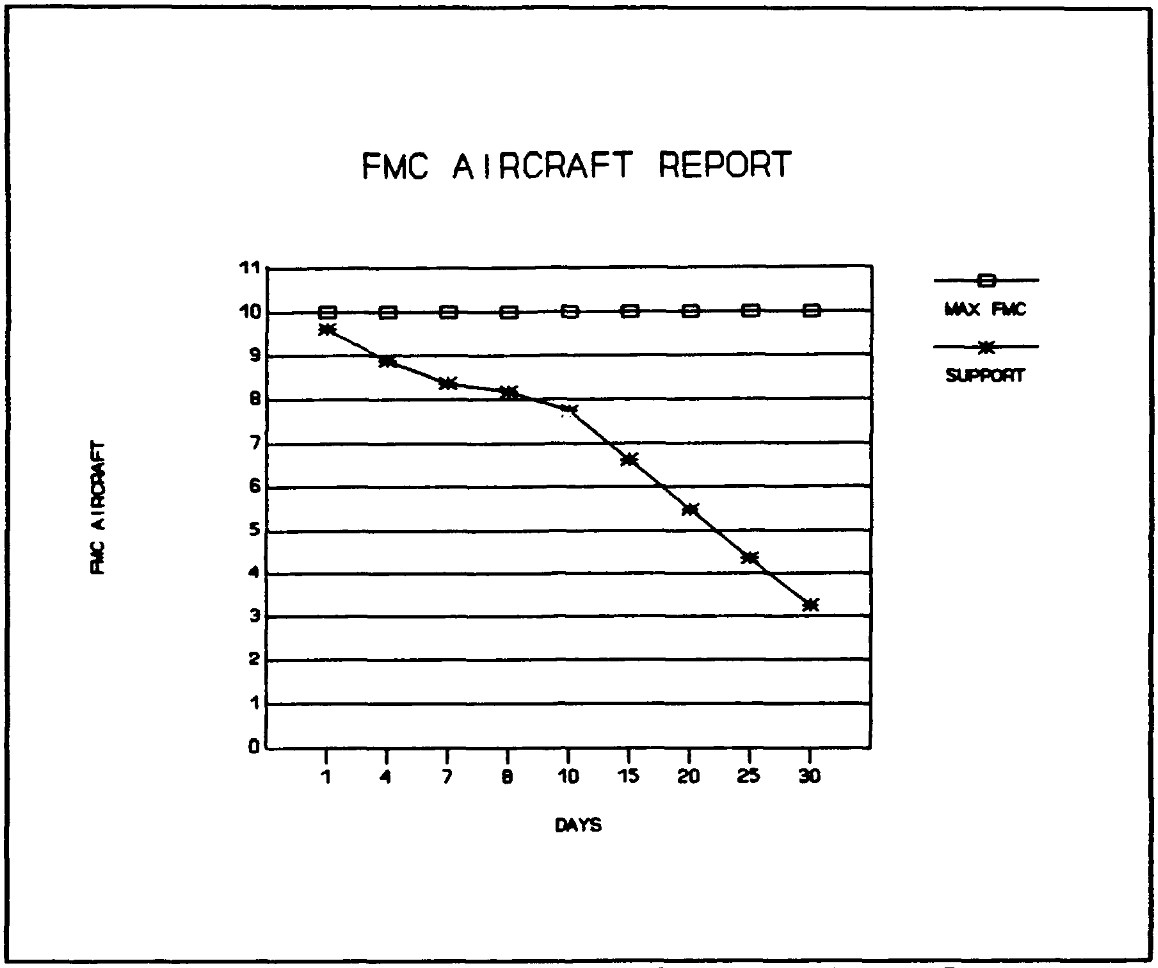


Figure 15. Impact of Adding Part #1 Qty Two to the Kit on FMC Aircraft

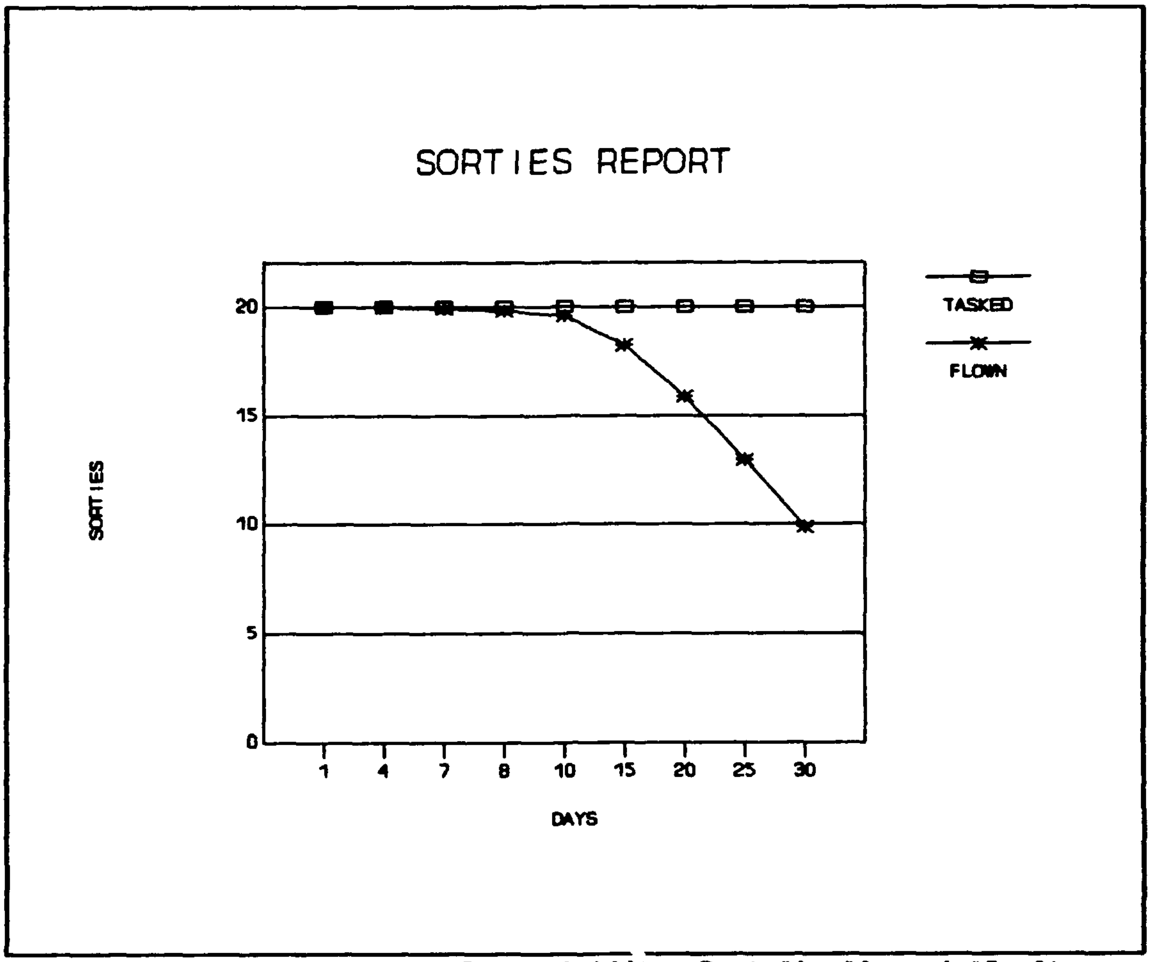


Figure 16. Impact on Sortie-Rate of Adding Part #1, #2, and #3, Qtys One, Twelve, and Three to the Kit, Respectively

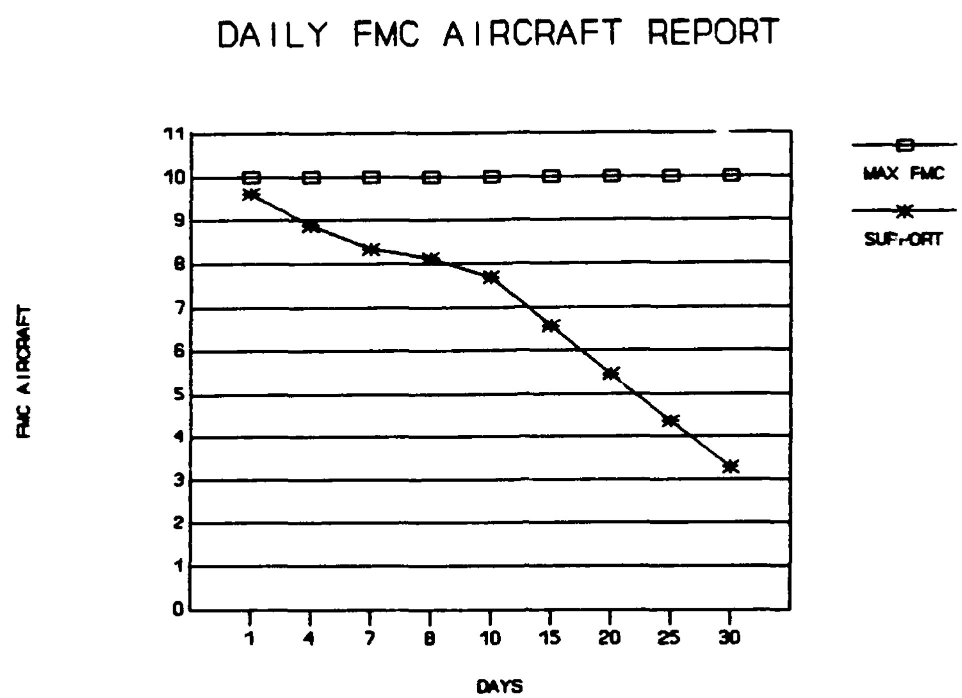


Figure 17. Impact on FMC Aircraft of Adding Part #1, #2, and #3, Qtys One, Twelve, and Three to the Kit, Respectively

TABLE 7

COMPARISON OF OUTPUTS FROM DIFFERENT KITS

Run Number	Kit Details	Output Sorties	Output FMC Aircraft	Kit Cost (Dollars)
1.	Initial PAF Kit of 75 Items	7.88(39.4%)	2.63(26.3%)	1.52M
2.	Model's Computed Kit	19.27(96.4%)	7.19(71.9%)	3.80M
3.	Rationalized Kit with 50 Parts	7.88(39.4%)	2.63(26.3%)	1.22M
4.	Rationalized Kit Plus Problem Part #1 Qty 1	8.95(44.8%)	2.99(29.9%)	1.37M
5.	Rationalized Kit Plus Problem Part #1 Qty 2	9.76(48.8%)	3.26(32.6%)	1.51M
6.	Rationalized Kit Plus Problem Part #1 Qty 1, Part #2 Qty 12, and Part #3 Qty 3	9.85(49.3%)	3.29(32.9%)	1.51M

V. Conclusions and Recommendations

Overview

The Forward Operational Bases (FOBs) Deployment Kits play a vital role in providing reparable component support to the units deployed for operations during exercises and wars. This chapter reviews findings of the research conducted on the PAF F-16 FOB Deployment Kit and makes specific recommendations pertaining to those findings stressing actions needed to improve FOB Deployment kit management by applying DMAS. The chapter closes with recommendations for further research in this field and for improvements to DMAS.

Conclusions

DMAS is a very user friendly model. The user can effectively operate this model without knowing details about the mathematical computation that take place in the process. The Dyna-METRIC Inventory Model demonstrated a great potential for use as a tool for computing FOB Deployment Kit requirements. The model's application to the representative PAF FOB Kit indicated overstockage of some components which were not expected to be utilized to support operations while other needed items were insufficiently stocked.

The most advantageous characteristic of the model was its capability to relate support requirements to the potential for operational output of a unit. A manager can use DMAS to find out, well before going into actual operations, the level of support he is expected to obtain from a given FOB Deployment Kit. In addition, the flexibility

of the model allows him to manipulate the kit to optimize its support by stocking only mission essential items.

All the outputs generated by DMAS are useful in one way or the other. The run on the Deployment Computation mode identified 25 out of the 75 items in the PAF kit were not expected to be used. This assumption was tested and verified by comparing the support provided by the initial 75-item kit with the 50-item kit (recommended by DMAS). A careful study of the DMAS capability also revealed a good chance of using the Problem Parts Report for effecting improvement in the PAF FOB Kit. This report generated a list of the five top Problem Parts which were forecast to impact operations. In addition, the Problem Parts Plot indicated the exact day of operations a component was expected to ground an aircraft. This information could be used by the kit manager as a forewarning of the problem areas. This capability of the model provided managers the opportunity for investing the amount saved, by eliminating excess stock from the initial kit, in procuring additional quantities of the appropriate Problem Parts needed to improve the kit stock level and the support provided by the kit.

The researcher was able to use the Problem Parts Report to add the identified Problem Parts in various combinations and evaluate their influence on the results in the form of operational outputs. Elimination of the excess requirements saved $297,393 in the cost of the kit. Within this potentially saved amount, the three top Problem Parts (as reflected in Table 6) were added in various quantities to compute a better mix to approach a more optimal support level. The outcomes of these trials indicated an increase in the daily sorties rate from 7.88

(39.4%) to 9.85 (49.3%) and the FMC aircraft availability from 2.63 (26.3%) to 3.29 (32.9%) on thirtieth day of operations. This data implies the unit's capability to fly two additional sorties and the availability of one additional FMC aircraft on the thirtieth day of operations. This increase was made possible by application of DMAS to the representative PAF FOB kit and without spending extra dollars. What does this mean in the real world? The reallocation of the $297,393 resulted in availability of one additional FMC aircraft, worth about $20 million, on the last day of operations. Apart from this, the chance of utilizing the services of a highly trained pilot would be lost if no aircraft was available. The importance of the availability of a FMC F-16 aircraft at that critical moment in a war cannot be over emphasized.

It was observed, from daily sortie rates and FMC aircraft availability reports and graphs, that the support remained almost steady for the first ten days. After this point, operations suffered a sudden and a relatively steep decline. The exact causes of this peculiar phenomenon need further research.

Another noteworthy consideration is the cost of the Problem Parts with respect to the pattern of their demand. The cost of the Problem Part #1, $145,487, was humongous, followed by Part #2, only $1619, whereas cost of the cheapest item on the kit was $236. The amount of $297,393, saved by application of DMAS to the PAF kit, would have been enough to purchase the entire quantities of all the Problem Parts, to boost up the kit support to well above the 90 percent level, if the average cost of each Problem Part was equal to or less than $7253. This amount was determined by dividing $297,393 (the total saving) by 41 (the

total Problem Parts given in Table 6). Unfortunately, the parts don't break in the ascending price orders, the one with the least cost being the *first to* break.

Recommendations

The results of this research strongly suggest that the PAF should use DMAS for F-16 FOB Deployment Kit requirement computation. Project Falcon, Air Headquarters, Pakistan Air Force, should study the results of this research and consider introduction of DMAS into the PAF. It is also considered essential that a complete database reflecting the total PAF F-16 FOB Kit should be built with the help of RAND Corporation. It is expected that the most reasonable means of accomplishing this would be by approaching RAND through USAF channels. A true validation of the model using this proposed database should be conducted by evaluating the support predicted for the kit (as calculated by the model) after flying a certain number of actual sorties.

The DMAS inputs, in the USAF, come from WSMIS and SBSS; the analogous sources are already automated in the PAF. These sources should be appropriately configured in order to make them usable by the DMAS.

DMAS handles only reparable (XD2) items whereas, in the real world, expendable (XB3) items also result in grounding of aircraft. Therefore, the operational output predicted by DMAS will become meaningless without inclusion of XB3 items into the kit, thereby taking into account their role in the whole process. It is recommended that the RAND corporation and the DRC should consider inclusion of XB3 items into the model for total evaluation of the "complete" kit. However, until this is done the

FOB kit should have an additional part dedicated to carrying mission essential XB3 items. Moreover, the reasons for the observed sudden and steep drop in the daily sorties rate and FMC aircraft availability immediately following the tenth day of operations, in almost all of the computer runs, need to be investigated.

After DMAS has been successfully introduced, the PAF should stay in touch with the USAF to keep abreast of the latest advancements in this highly useful area of computer application in the field of Logistics. For this purpose, the PAF should approach appropriate USAF authorities to obtain, on a regular basis, all issues of The Air Force Journal of Logistics and the pamphlets issued on the research conducted on Dyna-METRIC by the Air Force Logistics Command (AFLC).

AFLC or the Dynamic Research Corporation should create the capability in DMAS to provide an additional report which should be able to convert a given dollar amount directly into the sorties and FMC aircraft availability by proposing possible mixes of additional Problem Parts to the existing kit. At present, this process cannot be done automatically with DMAS and, therefore, was done by the author through arbitrary manipulations, manually.

A Final Note

The reader must realize that the daily sorties generation and the FMC aircraft availability predicted by DMAS are based on probability distributions and are not to be expected as the exact figures for use in the area of planning operations. The actual figures will be influenced by variability in many other factors contributing to the success of the operations. Therefore, a thorough understanding of model inputs, and

processes is needed to properly interpret the outputs. This is a model based on parts sustainability. Operational factors, such as air base attacks, destruction of resources, and personnel attrition are not modeled. This needs to be accounted for when using this model's outputs for war-time decision making.

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VITA

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13. ABSTRACT *(Maximum 200 words)*
The Pakistan Air Force (PAF) uses Forward Operational Bases Deployment Kits, a version of War Readiness Spares Kit in the USAF. This kit stocks repair components required to ensure uninterrupted supply support during operational exercises and war deployments. This study was designed to evaluate the existing PAF Deployment Kit by applying the Dyna-METRIC inventory model. A literature search revealed that the Dyna-METRIC Microcomputer Analysis System (DMAS), developed by the Dynamic Research Corporation for use on personal computers, was a suitable tool by reason of its usefullness, economy, and greater chance of application in the PAF. The model was used to analyze a representative kit of 75 line items to study effectiveness of stock levels required to generate an optimum number of sorties and to ensure the availability of a greater number of Fully Mission Capable aircraft throughout the period of deployment. The study successfully identified required stock levels, recommended deletion of excessive inventory, and also proposed additional levels in the kit of problem parts, the parts most often required to prevent the grounding of aircraft. Keywords: ,

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